Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Reassessment of Federal Communications	)	ET Docket No. 13-84
Commission Radiofrequency Exposure	)	
Limits and Policies	)	
	)	

REPLY TO COMMENTS SUBMITTED BY DR JAMES LIN ON 11 July 2013

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Background

This submission is a reply to comments submitted by Dr James Lin on 11th July 2013 regarding ET Docket No. 13-84.

This submission represents my own views, and is offered in the context of my past 24 years' experience as a researcher, educator, policy advisor and expert consultant in the area of biological and health effects associated with exposure to radiofrequency (RF) electromagnetic fields (EMF).

I am an engineer with a doctorate in biophysics. I have also received undergraduate training in the medical sciences. I am an Associate Investigator for the Australian Centre of Electromagnetics Bioeffects Research (ACEBR) and am an Honorary Principal Fellow of the University of Wollongong, Australia. I have co-authored 28 peer reviewed journal publications or book chapters and 53 conference papers in the area of bioelectromagnetics, specializing mostly in electromagnetic and thermal dosimetry. Since 1995 I have been a member of various national and international standards committees for drafting safety policy and assessment methodologies for human exposure to RF EMF as follows:

- Member of the TE/7 sub-committee of Standards Australia for drafting the AS/NZS 2772.1:1998 safety Standard for human exposure to RF EMF and the AS/NZS 2772.2:2011 standard for measurement and calculation of RF EMF exposure levels.
- Member of the working group for drafting the ARPANSA[1] radiation protection standard (RPS3) for human exposure to RF EMF.
- Committee member of the ICES[2] IEEE[3] Standards Coordinating Committee SCC-39, and Sub-Committees SC-4 and SC-2, for the development of safety standards for human exposure to RF EMF (C95.1) and lower EMF frequencies (C95.6), and for the implementation RF EMF safety programs (C95.7).
- Senior consultant for the development of the CITC[4] 2008 Saudi National Guidelines for human exposure to RF fields.
- Consultant to the PT62232 working group of the International Electrotechnical Commission (IEC) for determination of RF EMF in the vicinity of mobile communication base stations for the purpose of evaluating human exposure.

I am an honorary technical assessor for the Australian National Association of Testing Authorities (NATA) for reviewing laboratories which seek quality accreditation for measured and calculated assessment of human exposure to EMF. I am the Deputy Australian delegate for Commission K of the Union of Radio Science International (URSI), and a member of the Bioelectromagnetics Society (BEMS) and the Institute of Electrical and Electronics Engineers (IEEE).

[1] Australian Radiation Protection and Nuclear Safety Agency
[2] International Committee on Electromagnetic Safety
[3] Institute of Electrical and Electronics Engineers
[4] Communications and Information Technology Commission

Reply comments to submission from Lin

I am in substantial disagreement with the general sentiment and many of the comments provided by Dr Lin. In particular I wish to address his repudiation of three aspects of the localized SAR limits in the ICES/IEEE C95.1-2005 RF Safety Standard, i.e.,:

1. The cubic 10g averaging mass
2. The 2 W/kg SAR limit for general public RF exposure in body parts which are not classified as extremities or pinnae
3. Pinnae following the same exposure limits as extremities

I firstly note that scholarly and detailed rationales are provided by ICES for each of these aspects within the annexes of the C95.1-2005 standard (see sections C.2.2.2.1 and C.7.5). It is therefore somewhat surprising and disappointing that Dr Lin appears to show no awareness or acknowledgement of these rationales in his commentary, especially given his standing as a long serving member of the ICES/IEEE committees, and now a member of the ICNIRP.

I also consider Dr Lin's implication that the SAR limits were mostly based on satisfying industry needs as highly inappropriate. The rigor and transparency of the ICES/IEEE approach in the development of the C95.1-2005 revision is clearly evident in the description of its processes provided in Annex A of the standard. As a member of the ICES subcommittees since the mid 90's, I can readily attest to ICES's commitment to this process. An enormous effort was expended within the ICES subcommittees in conducting thorough literature reviews which have been openly reported in peer reviewed papers. This important and substantial service should not be trivialized and disregarded on the basis of personal conspiracy theories.

For the FCC's and Dr Lin's benefit, I provide brief summaries of the ICES rationales for the three aspects noted above, as well as my refutations of Dr Lin's arguments.

<u>Rationale for localized SAR limits</u>

To understand the setting of the parameters for the SAR limit it is essential to properly recognize its rationale, which is to protect against thermal tissue damage due to excessive temperature rise from RF heating. That is its sole purpose. Other established mechanisms for adverse RF effects are regulated by other types of limits, e.g., electrostimulation of excitable tissues at low frequencies is controlled by in situ electric field strength (E_i) limits, which are arithmetic averages determined over a straight line segment of 5 mm length oriented in any direction within the tissue but with no averaging mass.

Many mechanisms for adverse RF effects have been proposed in the literature and were duly reviewed by the ICES subcommittees. However only heating, electrostimulation and high field effects were considered as credible possibilities for causing adverse effects. This is a view that is stated in both the IEEE C95.1-2005 standard and the ICNIRP 1998 guidelines, and is commonly accepted by health and regulatory agencies around the world. It would be counterproductive to co-opt limits based on these established effects for other hypothecated mechanisms of harm whose existence are only speculative and whose natures are unknown.

In my view, given a fairly comprehensive study of this area in several thousands of diverse studies conducted over more than 60 years, and given constraints imposed by well-established laws of physics there is exceedingly little prospect of discovering a new established mechanism for RF induced harm. In that case, I agree with the approach taken by both IEEE ICES and ICNIRP to shape standards in the most effective way possible for protection against the adverse effects that we do know about.

<u>Cubic 10g averaging mass for localized SAR limits</u>

Given that the localized SAR limit is intended to protect against excessive RF heating, then it makes good sense to set the parameters of this limit in a way that would best correlate with temperature rise due to RF heating. This indeed is the approach adopted by ICES as explained in section C.7.5 of the C95.1 standard.

The complex geometries of human anatomy and the variable dielectric properties of its tissue types leads to a very heterogeneous pattern of induced SAR level when viewed at a very fine (point) scale. However, the unevenness in point SAR is substantially smoothed out in the distribution of RF induced temperature rise (dT) because of thermal diffusion due to the conductivity of the tissues as well as mass heat transfer from blood flow. This thermal smoothing phenomenon can be readily seen in the plots of figure 1 in this submission, which have been drawn from a conference presentation and a proceedings paper [1] by my colleagues and myself.

An interesting ancillary observation from these plots is the relatively reduced levels of temperature rise that are seen in the brain. These lower dT levels are due to the added cooling effect afforded to the brain by its rich blood supply, giving it extra protection against SAR heating.

Figure 1 also shows plots of 1g and 10g averaged SAR for the same model. From these plots it is readily apparent that the 10g averaging leads to a smoothed distribution pattern that is more in line with dT than 1 g averaging. The improved correlation of 10g SAR with dT is also quite evident in the scatter plots of Figure 2. These observations have been reported in other papers from my colleagues and myself [2,3] and have also been independently validated in other peer reviewed studies [4,5].

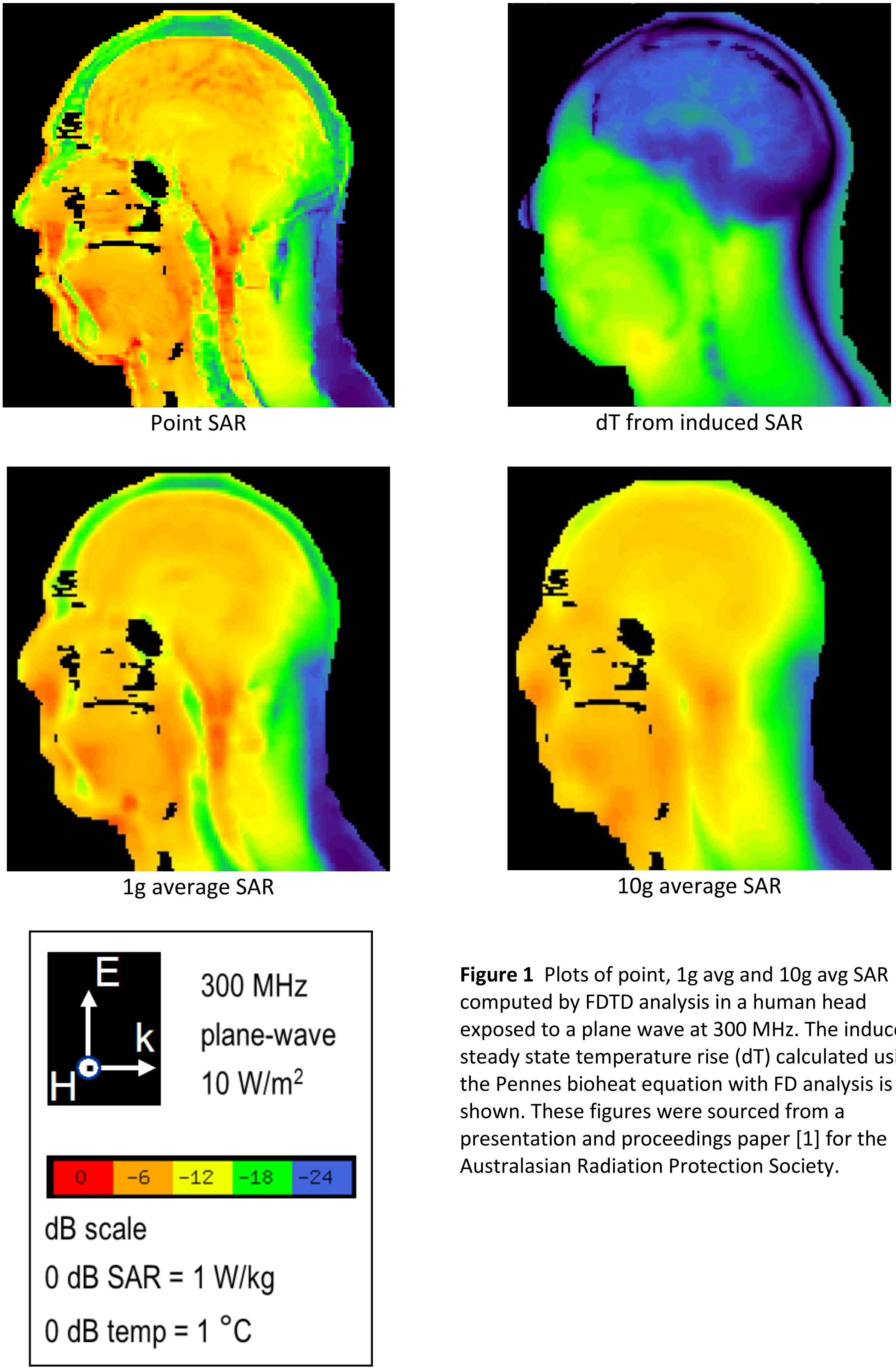

Figure 1 Plots of point, 1g avg and 10g avg SAR computed by FDTD analysis in a human head exposed to a plane wave at 300 MHz. The induced steady state temperature rise (dT) calculated using the Pennes bioheat equation with FD analysis is also shown. These figures were sourced from a presentation and proceedings paper [1] for the Australasian Radiation Protection Society.

Figure 4
The correlation between temperature change with point, 1 g averaged, and 10 g averaged SAR in the front quarter of the central anterior to posterior slice of the head and neck, at frequencies 300 to 3000 MHz, and at ambient power flux density at the ARPANSA limits as specified in Table 1. Around 1500 data points were used in each plot.

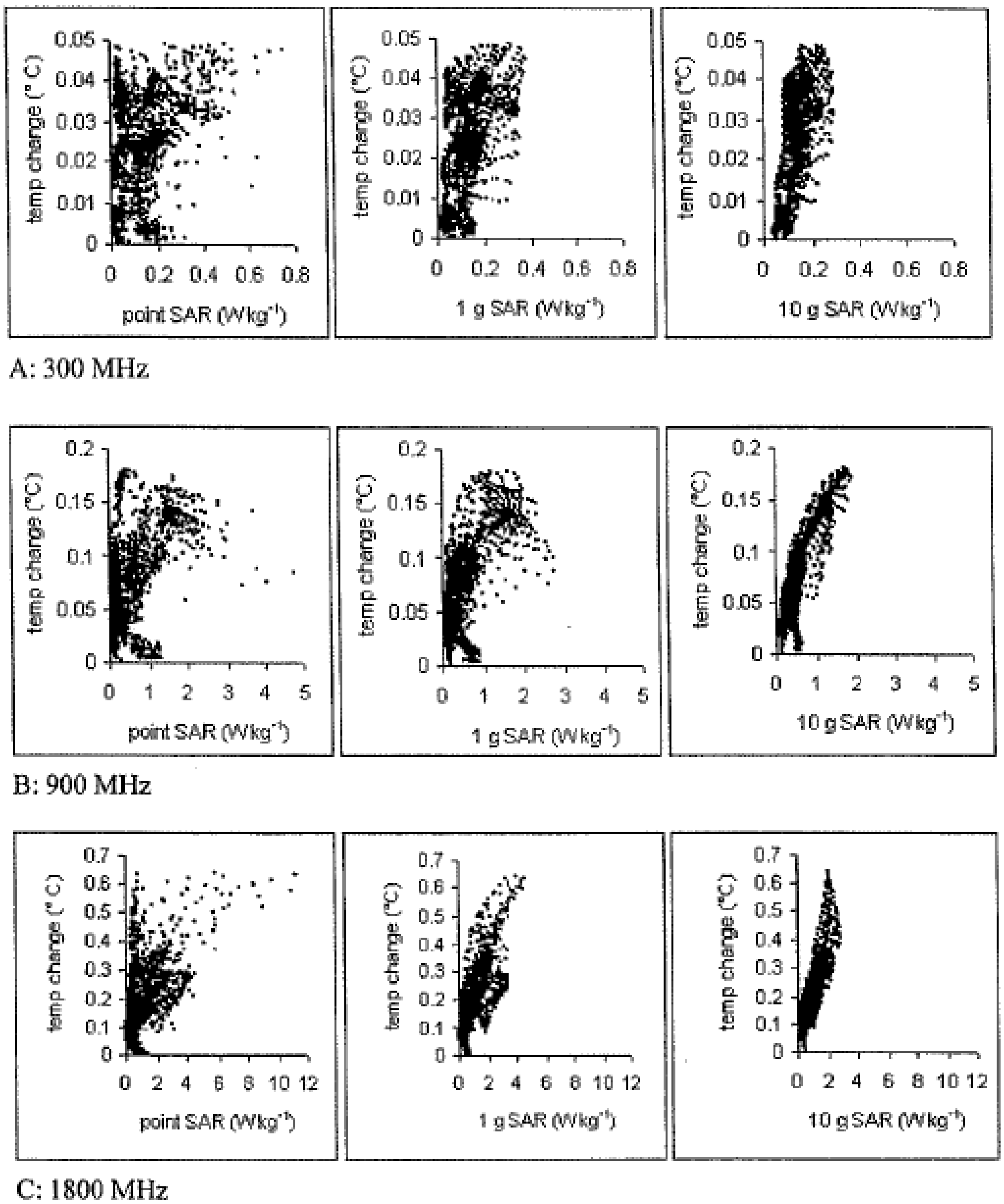

Figure 2: Scatter plots reproduced from [1] showing the correlation of dT with point, 1g average and 10g average SAR for plane wave exposures of the head at 300, 900 and 1800 MHz. The better correlation of dT with 10g average SAR is clearly evident in all three plots.

Dr Lin's argument that the size of the averaging masses for localised SAR limits should be based on the computational resolution of numerical models belies a basic lack of understanding of the ICES rationale. While finer computational meshes might yield more accurate results for point SAR distributions, this is completely irrelevant to the *physical* phenomenon of thermal diffusion as described above. The smoothed distribution of dT will still remain regardless of how finely the point SAR distribution has been calculated.

It is also worth noting that in the current assessment environment SAR compliance is not commonly assessed by calculation anyway, but rather by *measurement* using E-field probes immersed in *homogeneous* phantoms. For SAR testing of mobile phones the current standard measurement protocols incorporate additional large factors of safety by virtue of the way the phone is set up during testing, i.e.,:

- The RF output is set to maximum radiated power (3G and 4G phones typically operate at levels which are orders of magnitude lower)
- The phone is assumed to operate at 100% talk time over a six minute period (phones radiate much less when the user is only listening)
- The phone is positioned in cheek touching and 15 degree tilt positions (users rarely hold a phone over a prolonged period in the one worst case position)
- The geometry and dielectric composition of the testing phantom are designed to give conservative SAR results compared to real heads

<u>2 W/kg general public localized SAR limit</u>

The ICES is open in the C95.1 standard in recognising the potential benefits of harmonizing their recommendations with those of other standards, including the levels of its localized SAR limits with those recommended by the ICNIRP. They acknowledge that the ICNIRP guidelines are widely accepted and used around the world and recognise the reputable expertise that ICNIRP provided in developing them. It is therefore rather strange to me that Dr Lin as a member of ICNIRP would seek to criticise ICES in aligning itself with the ICNIRP limits.

Apart from leveraging off the expertise of other expert bodies, harmonization provides other important benefits to the general public, government, and industry. It simplifies and enhances the development of compliance standards by allowing more human technical resources to be concentrated on fewer standards development tasks. Manufacturers benefit from the global harmonization through the reduction of duplicate compliance schemes, leading to faster and cheaper delivery of products to general public consumers. Lastly, harmonization makes it easier for regulators like the FCC to check compliance with safety standards since common standards allow better sharing of testing procedures, equipment, tools, expertise and compliance data across the world.

Despite these obvious benefits however, the ICES did not adopt an uncritical approach to harmonization. The literature on localised SAR heating effects was duly reviewed (see section C.2.2.2 in the C95.1 standard), with particular attention to thermal damage in sensitive tissues such as the brain and eyes. The main and over-riding priority within ICES has always been to ensure that its limits are science based.

<u>Pinnae following the same exposure limits as extremities</u>

Again, as for the previous points, the ICES rationale for pinnae to follow the same exposure limits as extremities is clearly explained in the C95.1 standard – see section C.2.2.2.3. Briefly, the ICES note that the tissues which comprise the pinnae (skin, cartilage, fat, muscle, blood vessels and peripheral nerves) are of the same types to those found in the extremities (i.e., the lower legs and forearms) and hence can be expected to exhibit the same levels of thermotolerance to RF heating.

Dr Lin's argument that the pinnae should be considered to be as thermally vulnerable as sensitive organs such as the eyes and brain by virtue of being attached to the same head is nothing more than contrived semantics with no scientific basis.

Conclusion

I hope that my comments in this submission not only clear up Dr Lin's misconceptions but also help to reinforce the FCC's understanding of the considerable rigor and quality of the ICES/IEEE standards. I wholeheartedly recommend them to the FCC for serious consideration in the current review of your RF safety regulations.

V. Anderson

Dr Vitas Anderson (BEng, PhD)
(16th Nov 2013)

Bibliography

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[2] V. Anderson, R. Croft, and R. L. McIntosh, "SAR versus S(inc): What is the appropriate RF exposure metric in the range 1-10 GHz? Part I: Using planar body models," Bioelectromagnetics, vol. 31, 2010.

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